

HAWAII ADMINISTRATIVE RULES

TITLE 12

DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

SUBTITLE 8

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

PART 3

CONSTRUCTION STANDARDS

CHAPTER 134.1

UNDERGROUND CONSTRUCTION, CAISSONS,
COFFERDAMS, AND COMPRESSED AIR

§12-134.1-1 Incorporation of federal standard
§12-134.1-2 Definitions

Historical note: Chapter 12-134.1 is based substantially upon chapter 12-134. [Eff 7/12/82; am 8/5/88; am 3/22/91; am 6/8/92; am 8/10/95; am 1/26/96; R 9/21/96]

§12-134.1-1 Incorporation of federal standard. Title 29, Code of Federal Regulations, Subpart S, entitled "Underground Construction, Caissons, Cofferdams, and Compressed Air", published by the Office of the Federal Register, National Archives and Records Administration, on February 9, 1979; and the amendments published on April 6, 1979; April 6, 1982; July 11, 1986; June 2, 1989; June 30, 1993; January 8, 1998; and April 3, 2006, are made a part of this chapter, except as provided in section 12-134.1-2. [Eff 9/21/96; am 7/6/98; am 12/21/06] (Auth: HRS §396-4) (Imp: HRS §396-4)

§1926.800 Underground construction.

(a) Scope and application.

- (1) This section applies to the construction of underground tunnels, shafts, chambers, and passageways. This section also applies to cut-and-cover excavations which are both physically connected to ongoing underground construction operations within the scope of this section, and covered in such a manner as to create conditions characteristic of underground construction.
- (2) This section does not apply to the following:
 - (i) Excavation and trenching operations covered by Subpart P of this part, such as foundation operations for above-ground structures that are not physically connected to underground construction operations, and surface excavation; nor
 - (ii) Underground electrical transmission and distribution lines, as addressed in Subpart V of this part.

(b) Access and egress.

- (1) The employer shall provide and maintain safe means of access and egress to all workstations.
- (2) The employer shall provide access and egress in such a manner that employees are protected from being struck by excavators, haulage machines, trains and other mobile equipment.
- (3) The employer shall control access to all openings to prevent unauthorized entry underground. Unused chutes, manways, or other openings shall be tightly covered, bulk headed, or fenced off, and shall be posted with warning signs indicating "Keep Out" or similar language. Completed or unused sections of the underground facility shall be barricaded.

(c) Check-in/check-out. The employer shall maintain a check-in/check-out procedure that will ensure that aboveground personnel can determine an accurate count of the number of persons underground in the event of an emergency. However, this procedure is not required when the construction of underground facilities designed for human occupancy has been sufficiently completed so that the permanent environmental controls are effective, and when the remaining construction activity will not cause any environmental hazard or structural failure within the facilities.

(d) Safety instruction. All employees shall be instructed in the recognition and avoidance of hazards associated with underground construction activities including, where appropriate, the following subjects:

- (1) Air monitoring;
- (2) Ventilation;
- (3) Illumination;
- (4) Communications;
- (5) Flood control;
- (6) Mechanical equipment;
- (7) Personal protective equipment;
- (8) Explosives;
- (9) Fire prevention and protection; and
- (10) Emergency procedures, including evacuation plans and check-in/check-out systems.

(e) Notification.

- (1) Oncoming shifts shall be informed of any hazardous occurrences or conditions that have affected or might affect employee safety, including liberation of gas, equipment failures, earth or rock slides, cave-ins, flooding, fires or explosions.
- (2) The employer shall establish and maintain direct communications for coordination of activities with other employers whose operations at the jobsite affect or may affect the safety of employees underground.

(f) Communications.

- (1) When natural unassisted voice communication is ineffective, a power-assisted means of voice communication shall be used to provide communication between the work face, the bottom of the shaft, and the surface.
- (2) Two effective means of communication, at least one of which shall be voice communication, shall be provided in all shafts that are being developed or used either for personnel access or for hoisting. Additional requirements for hoist operator communication are contained in paragraph (t)(3)(xiv) of this section.

- (3) Powered communication systems shall operate on an independent power supply, and shall be installed so that the use of or disruption of any one phone or signal location will not disrupt the operation of the system from any other location.
 - (4) Communication systems shall be tested upon initial entry of each shift to the underground, and as often as necessary at later times, to ensure that they are in working order.
 - (5) Any employee working alone underground in a hazardous location, who is both out of the range of natural unassisted voice communication and not under observation by other persons, shall be provided with an effective means of obtaining assistance in an emergency.
- (g) Emergency provisions**
- (1) Hoisting capability. When a shaft is used as a means of egress, the employer shall make advance arrangements for power-assisted hoisting capability to be readily available in an emergency, unless the regular hoisting means can continue to function in the event of an electrical power failure at the jobsite. Such hoisting means shall be designed so that the load hoist drum is powered in both directions of rotation and so that the brake is automatically applied upon power release or failure.
 - (2) Self-rescuers. The employer must provide self-rescuers approved by the National Institute for Occupational Safety and Health under 42 CFR part 84. The respirators must be immediately available to all employees at workstations in underground areas where employees might be trapped by smoke or gas. The selection, issuance, use, and care of respirators must be in accordance with 29 CFR 1926.103.
 - (3) Designated person. At least one designated person shall be on duty above ground whenever any employee is working underground. This designated person shall be responsible for securing immediate aid and keeping an accurate count of employees underground in case of emergency. The designated person must not be so busy with other responsibilities that the counting function is encumbered.
 - (4) Emergency lighting. Each employee underground shall have an acceptable portable hand lamp or cap lamp in his or her work area for emergency use, unless natural light or an emergency lighting system provides adequate illumination for escape.
 - (5) Rescue teams.
 - (i) On jobsites where 25 or more employees work underground at one time, the employer shall provide (or make arrangements in advance with locally available rescue services to provide) at least two 5-person rescue teams, one on the jobsite or within one-half hour travel time from the entry point, and the other within 2 hours travel time.
 - (ii) On jobsites where less than 25 employees work underground at one time, the employer shall provide (or make arrangements in advance with locally available rescue services to provide) at least one 5-person rescue team to be either on the jobsite or within one-half hour travel time from the entry point.
 - (iii) Rescue team members shall be qualified in rescue procedures, the use and limitations of breathing apparatus, and the use of firefighting equipment. Qualifications shall be reviewed not less than annually.
 - (iv) On jobsites where flammable or noxious gases are encountered or anticipated in hazardous quantities, rescue team members shall practice donning and using self-contained breathing apparatus monthly.
 - (v) The employer shall ensure that rescue teams are familiar with conditions at the jobsite.
- (h) Hazardous classifications**
- (1) Potentially gassy operations. Underground construction operations shall be classified as potentially gassy if either:
 - (i) Air monitoring discloses 10 percent or more of the lower explosive limit for methane or other flammable gases measured at 12 inches (304.8 mm) \pm 0.25 inch (6.35 mm) from the roof, face, floor or walls in any underground work area for more than a 24-hour period; or
 - (ii) The history of the geographical area or geological formation indicates that 10 percent or more of the lower explosive limit for methane or other flammable gases is likely to be encountered in such underground operations.
 - (2) Gassy operations. Underground construction operations shall be classified as gassy if:
 - (i) Air monitoring discloses 10 percent or more of the lower explosive limit for methane or other flammable gases measured at 12 inches (304.8 mm) \pm 0.25 inch (6.35 mm) from the

- roof, face, floor or walls in any underground work area for three consecutive days; or
 - (ii) There has been an ignition of methane or of other flammable gases emanating from the strata that indicates the presence of such gases; or
 - (iii) The underground construction operation is both connected to an underground work area that is currently classified as gassy and is also subject to a continuous course of air containing the flammable gas concentration.
 - (3) Declassification to potentially gassy operations. Underground construction gassy operations may be declassified to Potentially Gassy when air-monitoring results remain under 10 percent of the lower explosive limit for methane or other flammable gases for three consecutive days.
- (i) Gassy operations-additional requirements.
 - (1) Only acceptable equipment, maintained in suitable condition, shall be used in gassy operations.
 - (2) Mobile diesel-powered equipment used in gassy operations shall be either approved in accordance with the requirements of 30 CFR part 36 (formerly Schedule 31) by MSHA, or shall be demonstrated by the employer to be fully equivalent to such MSHA-approved equipment, and shall be operated in accordance with that part.
 - (3) Each entrance to a gassy operation shall be prominently posted with signs notifying all entrants of the gassy classification.
 - (4) Smoking shall be prohibited in all gassy operations and the employer shall be responsible for collecting all personal sources of ignition, such as matches and lighters, from all persons entering a gassy operation.
 - (5) A fire watch as described in §1926.352(e) shall be maintained when hot work is performed.
 - (6) Once an operation has met the criteria in paragraph (h)(2) warranting classification as gassy, all operations in the affected area, except the following, shall be discontinued until the operation either is in compliance with all of the gassy operation requirements or has been declassified in accordance with paragraph (h)(3) of this section:
 - (i) Operations related to the control of the gas concentration:
 - (ii) Installation of new equipment, or conversion of existing equipment, to comply with this paragraph (i); and
 - (iii) Installation of aboveground controls for reversing the airflow.
- (j) Air quality and monitoring
 - (1) General. Air quality limits and control requirements for construction are found in §1926.55, except as modified by this section.
 - (i) (A) The employer shall assign a competent person who shall perform all air monitoring required by this section.
 - (B) Where this paragraph requires monitoring of airborne contaminants "as often as necessary," the competent person shall make a reasonable determination as to which substances to monitor and how frequently to monitor, considering at least the following factors:
 - (1) Location of jobsite: Proximity to fuel tanks, sewers, gas lines, old landfills, coal deposits, and swamps;
 - (2) Geology: Geological studies of the jobsite, particularly involving the soil type and its permeability;
 - (3) History: Presence of air contaminants in nearby jobsites, changes in levels of substances monitored on the prior shift; and
 - (4) Work practices and jobsite conditions: The use of diesel engines, use of explosives, use of fuel gas, volume and flow of ventilation, visible atmospheric conditions, decompression of the atmosphere, welding, cutting and hot work, and employees' physical reactions to working underground.
 - (ii) (A) The atmosphere in all underground work areas shall be tested as often as necessary to assure that the atmosphere at normal atmospheric pressure contains at least 19.5 percent oxygen and no more than 22 percent oxygen.
 - (B) Tests for oxygen content shall be made before tests for air contaminants.

- (iii) (A) The atmosphere in all underground work areas shall be tested quantitatively for carbon monoxide, nitrogen dioxide, hydrogen sulfide, and other toxic gases, dusts, vapors, mists, and fumes as often as necessary to ensure that the permissible exposure limits prescribed in §1926.55 are not exceeded.
- (B) The atmosphere in all underground work areas shall be tested quantitatively for methane and other flammable gases as often as necessary to determine:
 - (1) Whether action is to be taken under paragraphs (j)(1)(vii), (viii), and (ix), of this section; and
 - (2) Whether an operation is to be classified potentially gassy or gassy under paragraph (h) of this section.
- (C) If diesel-engine or gasoline-engine driven ventilating fans or compressors are used, an initial test shall be made of the inlet air of the fan or compressor, with the engines operating, to ensure that the air supply is not contaminated by engine exhaust.
- (D) Testing shall be performed as often as necessary to ensure that the ventilation requirements of paragraph (k) of this section are met.
- (iv) When rapid excavation machines are used, a continuous flammable gas monitor shall be operated at the face with the sensor(s) placed as high and close to the front of the machine's cutter head as practicable.
- (v) (A) Whenever air monitoring indicates the presence of 5 ppm or more of hydrogen sulfide, a test shall be conducted in the affected underground work area(s), at least at the beginning and midpoint of each shift, until the concentration of hydrogen sulfide has been less than 5 ppm for 3 consecutive days.
- (B) Whenever hydrogen sulfide is detected in an amount exceeding 10 ppm, a continuous sampling and indicating hydrogen sulfide monitor shall be used to monitor the affected work area.
- (C) Employees shall be informed when a concentration of 10 ppm hydrogen sulfide is exceeded.
- (D) The continuous sampling and indicating hydrogen sulfide monitor shall be designed, installed, and maintained to provide a visual and aural alarm when the hydrogen sulfide concentration reaches 20 ppm to signal that additional measures, such as respirator use, increased ventilation, or evacuation, might be necessary to maintain hydrogen sulfide exposure below the permissible exposure limit.
- (vi) When the competent person determines, on the basis of air monitoring results or other information, that air contaminants may be present in sufficient quantity to be dangerous to life, the employer shall:
 - (A) Prominently post a notice at all entrances to the underground jobsite to inform all entrants of the hazardous condition; and
 - (B) Ensure that the necessary precautions are taken.
- (vii) Whenever five percent or more of the lower explosive limit for methane or other flammable gases is detected in any underground work area(s) or in the air return, steps shall be taken to increase ventilation air volume or otherwise control the gas concentration, unless the employer is operating in accordance with the potentially gassy or gassy operation requirements. Such additional ventilation controls may be discontinued when gas concentrations are reduced below five percent of the lower explosive limit, but shall be reinstituted whenever the five percent level is exceeded.
- (viii) Whenever 10 percent or more of the lower explosive limit for methane or other flammable gases is detected in the vicinity of welding, cutting, or other hot work, such work shall be suspended until the concentration of such flammable gas is reduced to less than 10 percent of the lower explosive limit.
- (ix) Whenever 20 percent or more of the lower explosive limit for methane or other flammable gases is detected in any underground work area(s) or in the air return:
 - (A) All employees, except those necessary to eliminate the hazard, shall be immediately withdrawn to a safe location above ground; and
 - (B) Electrical power, except for acceptable pumping and ventilation equipment, shall be cut off to the area endangered by the flammable gas until the concentration of such

gas is reduced to less than 20 percent of the lower explosive limit.

- (2) Additional monitoring for potentially gassy and gassy operations. Operations that meet the criteria for potentially gassy and gassy operations set forth in paragraph (h) of this section shall be subject to the additional monitoring requirements of this paragraph.
 - (i) A test for oxygen content shall be conducted in the affected underground work areas and work areas immediately adjacent to such areas at least at the beginning and midpoint of each shift.
 - (ii) When using rapid excavation machines, continuous automatic flammable gas monitoring equipment shall be used to monitor the air at the heading, on the rib, and in the return air duct. The continuous monitor shall signal the heading, and shut down electric power in the affected underground work area, except for acceptable pumping and ventilation equipment, when 20 percent or more of the lower explosive limit for methane or other flammable gases is encountered.
 - (iii) A manual flammable gas monitor shall be used as needed, but at least at the beginning and midpoint of each shift, to ensure that the limits prescribed in paragraphs (h) and (j) are not exceeded. In addition, a manual electrical shut down control shall be provided near the heading.
 - (iv) Local gas tests shall be made prior to and continuously during any welding, cutting, or other hot work.
 - (v) In underground operations driven by drill-and-blast methods, the air in the affected area shall be tested for flammable gas prior to re-entry after blasting, and continuously when employees are working underground.
 - (3) Record keeping. A record of all air quality tests shall be maintained above ground at the worksite and be made available to the Secretary of Labor upon request. The record shall include the location, date, time, substance and amount monitored. Records of exposures to toxic substances shall be retained in accordance with §1926.33 of this chapter. All other air quality test records shall be retained until completion of the project.
- (k) Ventilation.**
- (1)
 - (i) Fresh air shall be supplied to all underground work areas in sufficient quantities to prevent dangerous or harmful accumulation of dusts, fumes, mists, vapors or gases.
 - (ii) Mechanical ventilation shall be provided in all underground work areas except when the employer can demonstrate that natural ventilation provides the necessary air quality through sufficient air volume and air flow.
 - (2) A minimum of 200 cubic feet (5.7 m³) of fresh air per minute shall be supplied for each employee underground.
 - (3) The linear velocity of air flow in the tunnel bore, in shafts, and in all other underground work areas shall be at least 30 feet (9.15 m) per minute where blasting or rock drilling is conducted, or where other conditions likely to produce dust, fumes, mist, vapors or gases in harmful or explosive quantities are present.
 - (4) The direction of mechanical air flow shall be reversible.
 - (5) Following blasting, ventilation systems shall exhaust smoke and fumes to the outside atmosphere before work is resumed in affected areas.
 - (6) Ventilation doors shall be designed and installed so that they remain closed when in use, regardless of the direction of the air flow.
 - (7) When ventilation has been reduced to the extent that hazardous levels of methane or flammable gas may have accumulated, a competent person shall test all affected areas after ventilation has been restored and shall determine whether the atmosphere is within flammable limits before any power, other than for acceptable equipment, is restored or work is resumed.
 - (8) Whenever the ventilation system has been shut down with all employees out of the underground area, only competent persons authorized to test for air contaminants shall be allowed underground until the ventilation has been restored and all affected areas have been tested for air contaminants and declared safe.
 - (9) When drilling rock or concrete, appropriate dust control measures shall be taken to maintain dust levels within limits set in §1926.65. Such measures may include, but are not limited to, wet drilling, the use of vacuum collectors, and water mix spray systems.

- (10) (i) Internal combustion engines, except diesel-powered engines on mobile equipment, are prohibited underground.
- (ii) Mobile diesel-powered equipment used underground in atmospheres other than gassy operations shall be either approved by MSHA in accordance with the provisions of 30 CFR part 32 (formerly Schedule 24), or shall be demonstrated by the employer to be fully equivalent to such MSHA-approved equipment, and shall be operated in accordance with that part. (Each brake horsepower of a diesel engine requires at least 100 cubic feet (28.32 m³) of air per minute for suitable operation in addition to the air requirements for personnel. Some engines may require a greater amount of air to ensure that the allowable levels of carbon monoxide, nitric oxide, and nitrogen dioxide are not exceeded.)
- (11) Potentially gassy or gassy operations shall have ventilation systems installed that shall:
 - (i) Be constructed of fire-resistant materials; and
 - (ii) Have acceptable electrical systems, including fan motors.
- (12) Gassy operations shall be provided with controls located above ground for reversing the air flow of ventilation systems.
- (13) In potentially gassy or gassy operations, wherever mine-type ventilation systems using an offset main fan installed on the surface are used, they shall be equipped with explosion-doors or a weak-wall having an area at least equivalent to the cross-sectional area of the airway.
- (l) Illumination.
 - (1) Illumination requirements applicable to underground construction operations are found in Table D-3 of §1926.56 of this part.
 - (2) Only acceptable portable lighting equipment shall be used within 50 feet (15.24 m) of any underground heading during explosives handling.
- (m) Fire prevention and control. Fire prevention and protection requirements applicable to underground construction operations are found in Subpart F of this part, except as modified by the following additional standards.
 - (1) Open flames and fires are prohibited in all underground construction operations except as permitted for welding, cutting and other hot work operations in paragraph (n) of this section.
 - (2) (i) Smoking may be allowed only in areas free of fire and explosion hazards.
 - (ii) Readily visible signs prohibiting smoking and open flames shall be posted in areas having fire or explosion hazards.
 - (3) The employer may store underground no more than a 24-hour supply of diesel fuel for the underground equipment used at the worksite.
 - (4) The piping of diesel fuel from the surface to an underground location is permitted only if:
 - (i) Diesel fuel is contained at the surface in a tank whose maximum capacity is no more than the amount of fuel required to supply for a 24-hour period the equipment serviced by the underground fueling station; and
 - (ii) The surface tank is connected to the underground fueling station by an acceptable pipe or hose system that is controlled at the surface by a valve, and at the shaft bottom by a hose nozzle; and
 - (iii) The pipe is empty at all times except when transferring diesel fuel from the surface tank to a piece of equipment in use underground; and
 - (iv) Hoisting operations in the shaft are suspended during refueling operations if the supply piping in the shaft is not protected from damage.
 - (5) (i) Gasoline shall not be carried, stored, or used underground.
 - (ii) Acetylene, liquefied petroleum gas, and Methylacetylene Propadiene Stabilized gas may be used underground only for welding, cutting and other hot work, and only in accordance with Subpart J of this part, and paragraphs (j), (k), (m), and (n) of this section.
 - (6) Oil, grease, and diesel fuel stored underground shall be kept in tightly sealed containers in fire-resistant areas at least 300 feet (91.44m) from underground explosive magazines, and at least 100 feet (30.48m) from shaft stations and steeply inclined passageways. Storage areas shall be positioned or diked so that the contents of ruptured or overturned containers will not flow from the storage area.
 - (7) Flammable or combustible materials shall not be stored above ground within 100 feet (30.48m) of any access opening to any underground operation. Where this is not feasible because of

space limitations at the jobsite, such materials may be located within the 100-foot limit, provided that:

- (i) They are located as far as practicable from the opening; and
 - (ii) Either a fire-resistant barrier of not less than one-hour rating is placed between the stored material and the opening, or additional precautions are taken which will protect the materials from ignition sources.
- (8) Fire-resistant hydraulic fluids shall be used in hydraulically-actuated underground machinery and equipment unless such equipment is protected by a fire suppression system or by multipurpose fire extinguisher(s) rated at of sufficient capacity for the type and size of hydraulic equipment involved, but rated at least 4A:40B:C.
- (9) (i) Electrical installations in underground areas where oil, grease, or diesel fuel are stored shall be used only for lighting fixtures.
- (ii) Lighting fixtures in storage areas, or within 25 feet (7.62m) of underground areas where oil, grease, or diesel fuel are stored, shall be approved for Class I, Division 2 locations, in accordance with Subpart K of this part.
- (10) Leaks and spills of flammable or combustible fluids shall be cleaned up immediately.
- (11) A fire extinguisher of at least 4A:40B:C rating or other equivalent extinguishing means shall be provided at the head pulley and at the tail pulley of underground belt conveyors.
- (12) Any structure located underground or within 100 feet (30.48m) of an opening to the underground shall be constructed of material having a fire-resistance rating of at least one hour.
- (n) Welding, cutting, and other hot work.** In addition to the requirements of Subpart J of this part, the following requirements shall apply to underground welding, cutting, and other hot work.
- (1) No more than the amount of fuel gas and oxygen cylinders necessary to perform welding, cutting, or other hot work during the next 24-hour period shall be permitted underground.
 - (2) Noncombustible barriers shall be installed below welding, cutting, or other hot work being done in or over a shaft or raise.
- (o) Ground support**
- (1) Portal areas. Portal openings and access areas shall be guarded by shoring, fencing, head walls, shotcreting or other equivalent protection to ensure safe access of employees and equipment. Adjacent areas shall be scaled or otherwise secured to prevent loose soil, rock, or fractured materials from endangering the portal and access area.
 - (2) Subsidence areas. The employer shall ensure ground stability in hazardous subsidence areas by shoring, by filling in, or by erecting barricades and posting warning signs to prevent entry.
 - (3) Underground areas.
 - (i) (A) A competent person shall inspect the roof, face, and walls of the work area at the start of each shift and as often as necessary to determine ground stability.
 - (B) Competent persons conducting such inspections shall be protected from loose ground by location, ground support or equivalent means.
 - (ii) Ground conditions along haulageways and travelways shall be inspected as frequently as necessary to ensure safe passage.
 - (iii) Loose ground that might be hazardous to employees shall be taken down, scaled or supported.
 - (iv) (A) Torque wrenches shall be used wherever bolts that depend on torsionally applied force are used for ground support.
 - (B) A competent person shall determine whether rock bolts meet the necessary torque, and shall determine the testing frequency in light of the bolt system, ground conditions and the distance from vibration sources.
 - (v) Suitable protection shall be provided for employees exposed to the hazard of loose ground while installing ground support systems.
 - (vi) Support sets shall be installed so that the bottoms have sufficient anchorage to prevent ground pressures from dislodging the support base of the sets. Lateral bracing (collar bracing, tie rods, or spreaders) shall be provided between immediately adjacent sets to ensure added stability.

- (vii) Damaged or dislodged ground supports that create a hazardous condition shall be promptly repaired or replaced. When replacing supports, the new supports shall be installed before the damaged supports are removed.
- (viii) A shield or other type of support shall be used to maintain a safe travelway for employees working in dead-end areas ahead of any support replacement operation.
- (4) Shafts.
 - (i) Shafts and wells over 5 feet (1.53 m) in depth that employees must enter shall be supported by a steel casing, concrete pipe, timber, solid rock or other suitable material.
 - (ii) (A) The full depth of the shaft shall be supported by casing or bracing except where the shaft penetrates into solid rock having characteristics that will not change as a result of exposure. Where the shaft passes through earth into solid rock, or through solid rock into earth, and where there is potential for shear, the casing or bracing shall extend at least 5 feet (1.53 m) into the solid rock. When the shaft terminates in solid rock, the casing or bracing shall extend to the end of the shaft or 5 feet (1.53 m) into the solid rock, whichever is less.
 - (B) The casing or bracing shall extend 42 inches (1.07 m) plus or minus 3 inches (8 cm) above ground level, except that the minimum casing height may be reduced to 12 inches (0.3 m), provided that a standard railing is installed; that the ground adjacent to the top of the shaft is sloped away from the shaft collar to prevent entry of liquids; and that effective barriers are used to prevent mobile equipment operating near the shaft from jumping over the 12 inch (0.3 m) barrier.
 - (iii) After blasting operations in shafts, a competent person shall determine if the walls, ladders, timbers, blocking, or wedges have loosened. If so, necessary repairs shall be made before employees other than those assigned to make the repairs are allowed in or below the affected areas.
- (p) Blasting. This paragraph applies in addition to the requirements for blasting and explosives operations, including handling of misfires, which are found in Subpart U of this part.
 - (1) Blasting wires shall be kept clear of electrical lines, pipes, rails, and other conductive material, excluding earth, to prevent explosives initiation or employee exposure to electric current.
 - (2) Following blasting, an employee shall not enter a work area until the air quality meets the requirements of paragraph (j) of this section.
- (q) Drilling.
 - (1) A competent person shall inspect all drilling and associated equipment prior to each use. Equipment defects affecting safety shall be corrected before the equipment is used.
 - (2) The drilling area shall be inspected for hazards before the drilling operation is started.
 - (3) Employees shall not be allowed on a drill mast while the drill bit is in operation or the drill machine is being moved.
 - (4) When a drill machine is being moved from one drilling area to another, drill steel, tools, and other equipment shall be secured and the mast shall be placed in a safe position.
 - (5) Receptacles or racks shall be provided for storing drill steel located on jumbos.
 - (6) Employees working below jumbo decks shall be warned whenever drilling is about to begin.
 - (7) Drills on columns shall be anchored firmly before starting drilling, and shall be retightened as necessary thereafter.
 - (8) (i) The employer shall provide mechanical means on the top deck of a jumbo for lifting unwieldy or heavy material.
 - (ii) When jumbo decks are over 10 feet (3.05 m) in height, the employer shall install stairs wide enough for two persons.
 - (iii) Jumbo decks more than 10 feet (3.05 m) in height shall be equipped with guardrails on all open sides, excluding access openings of platforms, unless an adjacent surface provides equivalent fall protection.
 - (iv) (A) Only employees assisting the operator shall be allowed to ride on jumbos, unless the jumbo meets the requirements of paragraph (r)(6)(ii) of this section.
 - (B) Jumbos shall be chocked to prevent movement while employees are working on them.
 - (v) (A) Walking and working surfaces of jumbos shall be maintained to prevent the hazards of slipping, tripping and falling.

- (B) Jumbo decks and stair treads shall be designed to be slip-resistant and secured to prevent accidental displacement.
- (9) Scaling bars shall be available at scaling operations and shall be maintained in good condition at all times. Blunted or severely worn bars shall not be used.
- (10) (i) Blasting holes shall not be drilled through blasted rock (muck) or water.
- (ii) Employees in a shaft shall be protected either by location or by suitable barrier(s) if powered mechanical loading equipment is used to remove muck containing unfired explosives.
- (11) A caution sign reading "Buried Line," or similar wording shall be posted where air lines are buried or otherwise hidden by water or debris.
- (r) Haulage.
 - (1) (i) A competent person shall inspect haulage equipment before each shift.
 - (ii) Equipment defects affecting safety and health shall be corrected before the equipment is used.
 - (2) Powered mobile haulage equipment shall have suitable means of stopping.
 - (3) (i) Power mobile haulage equipment, including trains, shall have audible warning devices to warn employees to stay clear. The operator shall sound the warning device before moving the equipment and whenever necessary during travel.
 - (ii) The operator shall assure that lights that are visible to employees at both ends of any mobile equipment, including a train, are turned on whenever the equipment is operating.
 - (4) In those cabs where glazing is used, the glass shall be safety glass, or its equivalent, and shall be maintained and cleaned so that vision is not obstructed.
 - (5) Anti-roll back devices or brakes shall be installed on inclined conveyor drive units to prevent conveyors from inadvertently running in reverse.
 - (6) (i) (A) Employees shall not be permitted to ride a power-driven chain, belt, or bucket conveyor unless the conveyor is specifically designed for the transportation of persons.
 - (B) Endless belt type manlifts are prohibited in underground construction.
 - (C) General requirements also applicable to underground construction for use of conveyors in construction are found in §1926.555 of this part.
 - (ii) No employee shall ride haulage equipment unless it is equipped with seating for each passenger and protects passengers from being struck, crushed, or caught between other equipment or surfaces. Members of train crews may ride on a locomotive if it is equipped with handholds and non-slip steps or footboards. Requirements applicable to Underground Construction for motor vehicle transportation of employees are found in §1926.601 of this part.
 - (7) Powered mobile haulage equipment, including trains, shall not be left unattended unless the master switch or motor is turned off; operating controls are in neutral or park position; and the brakes are set, or equivalent precautions are taken to prevent rolling.
 - (8) Whenever rails serve as a return for a trolley circuit, both rails shall be bonded at every joint and crossbonded every 200 feet (60.96 m).
 - (9) When dumping cars by hand, the car dumps shall have tie-down chains, bumper blocks, or other locking or holding devices to prevent the cars from overturning.
 - (10) Rocker-bottom or bottom-dump cars shall be equipped with positive locking devices to prevent unintended dumping.
 - (11) Equipment to be hauled shall be loaded and secured to prevent sliding or dislodgement.
 - (12) (i) Mobile equipment, including rail-mounted equipment, shall be stopped for manual connecting or service work.
 - (ii) Employees shall not reach between moving cars during coupling operations.
 - (iii) Couplings shall not be aligned, shifted or cleaned on moving cars or locomotives.

- (13) (i) Safety chains or other connections shall be used in addition to couplers to connect man cars or powder cars whenever the locomotive is uphill of the cars.
- (ii) When the grade exceeds one percent and there is a potential for runaway cars, safety chains or other connections shall be used in addition to couplers to connect haulage cars or, as an alternative, the locomotive must be downhill of the train.
- (iii) Such safety chains or other connections shall be capable of maintaining connection between cars in the event of either coupler disconnect, failure or breakage.
- (14) Parked rail equipment shall be chocked, blocked, or have brakes set to prevent inadvertent movement.
- (15) Berms, bumper blocks, safety hooks, or equivalent means shall be provided to prevent overtravel and overturning of haulage equipment at dumping locations.
- (16) Bumper blocks or equivalent stopping devices shall be provided at all track dead ends.
- (17) (i) Only small hand tools, lunch pails or similar small items may be transported with employees in mancars, or on top of a locomotive.
- (ii) When small hand tools or other small items are carried on top of a locomotive, the top shall be designed or modified to retain them while traveling.
- (18) (i) Where switching facilities are available, occupied personnel-cars shall be pulled, not pushed. If personnel-cars must be pushed and visibility of the track ahead is hampered, then a qualified person shall be stationed in the lead car to give signals to the locomotive operator.
- (ii) Crew trips shall consist of personnel-loads only.
- (s) Electrical safety. This paragraph applies in addition to the general requirements for electrical safety that are found in Subpart K of this part.
 - (1) Electric power lines shall be insulated or located away from water lines, telephone lines, air lines, or other conductive materials so that a damaged circuit will not energize the other systems.
 - (2) Lighting circuits shall be located so that movement of personnel or equipment will not damage the circuits or disrupt service.
 - (3) Oil-filled transformers shall not be used underground unless they are located in a fire-resistant enclosure suitably vented to the outside and surrounded by a dike to retain the contents of the transformers in the event of rupture.
- (t) Hoisting unique to underground construction. Except as modified by this paragraph (t), the following provisions of Subpart N of this part apply: Requirements for cranes are found in §1926.550 of this part. Paragraph (g) of §1926.550 applies to crane hoisting of personnel, except that the limitation in paragraph (g)(2) does not apply to the routine access of employees to the underground via a shaft. Requirements for material hoists are found in §1926.552(a) and (b) of this part. Requirements for personnel hoists are found in the personnel hoist requirements of §1926.552(a) and (c) of this part and in the elevator requirement of §1926.552(a) and (d) of this part.
 - (1) General requirements for cranes and hoists.
 - (i) Materials, tools, and supplies being raised or lowered, whether within a cage or otherwise, shall be secured or stacked in a manner to prevent the load from shifting, snagging or falling into the shaft.
 - (ii) A warning light suitably located to warn employees at the shaft bottom and subsurface shaft entrances shall flash whenever a load is above the shaft bottom or subsurface entrances, or the load is being moved in the shaft. This paragraph does not apply to fully enclosed hoistways.
 - (iii) Whenever a hoistway is not fully enclosed and employees are at the shaft bottom, conveyances or equipment shall be stopped at least 15 feet (4.57 m) above the bottom of the shaft and held there until the signalman at the bottom of the shaft directs the operator to continue lowering the load, except that the load may be lowered without stopping if the load or conveyance is within full view of a bottom signalman who is in constant voice communication with the operator.
 - (iv) (A) Before maintenance, repairs, or other work is commenced in the shaft served by a cage, skip, or bucket, the operator and other employees in the area shall be informed and given suitable instructions.

- (B) A sign warning that work is being done in the shaft shall be installed at the shaft collar, at the operator's station, and at each underground landing.
- (v) Any connection between the hoisting rope and the cage or skip shall be compatible with the type of wire rope used for hoisting.
- (vi) Spin-type connections, where used, shall be maintained in a clean condition and protected from foreign matter that could affect their operation.
- (vii) Cage, skip, and load connections to the hoist rope shall be made so that the force of the hoist pull, vibration, misalignment, release of lift force, or impact will not disengage the connection. Moused or latched open-throat hooks do not meet this requirement.
- (viii) When using wire rope wedge sockets, means shall be provided to prevent wedge escapement and to ensure that the wedge is properly seated.
- (2) Additional requirements for cranes. Cranes shall be equipped with a limit switch to prevent overtravel at the boom tip. Limit switches are to be used only to limit travel of loads when operational controls malfunction and shall not be used as a substitute for other operational controls.
- (3) Additional requirements for hoists.
 - (i) Hoists shall be designed so that the load hoist drum is powered in both directions of rotation, and so that brakes are automatically applied upon power release or failure.
 - (ii) Control levers shall be of the "deadman type" which return automatically to their center (neutral) position upon release.
 - (iii) When a hoist is used for both personnel hoisting and material hoisting, load and speed ratings for personnel and for materials shall be assigned to the equipment.
 - (iv) Material hoisting may be performed at speeds higher than the rated speed for personnel hoisting if the hoist and components have been designed for such higher speeds and if shaft conditions permit.
 - (v) Employees shall not ride on top of any cage, skip or bucket except when necessary to perform inspection or maintenance of the hoisting system, in which case they shall be protected by a body belt/harness system to prevent falling.
 - (vi) Personnel and materials (other than small tools and supplies secured in a manner that will not create a hazards to employees) shall not be hoisted together in the same conveyance. However, if the operator is protected from the shifting of materials, then the operator may ride with materials in cages or skips which are designed to be controlled by an operator within the cage or skip.
 - (vii) Line speed shall not exceed the design limitations of the systems.
 - (viii) Hoists shall be equipped with landing level indicators at the operator's station. Marking of the hoist rope does not satisfy this requirement.
 - (ix) Whenever glazing is used in the hoist house, it shall be safety glass, or its equivalent, and be free of distortions and obstructions.
 - (x) A fire extinguisher that is rated at least 2A:10B:C (multi-purpose, dry chemical) shall be mounted in each hoist house.
 - (xi) Hoist controls shall be arranged so that the operator can perform all operating cycle functions and reach the emergency power cutoff without having to reach beyond the operator's normal operating position.
 - (xii) Hoists shall be equipped with limit switches to prevent overtravel at the top and bottom of the hoistway.
 - (xiii) Limit switches are to be used only to limit travel of loads when operational controls malfunction and shall not be used as a substitute for other operational controls.
 - (xiv) Hoist operators shall be provided with a closed-circuit voice communication system to each landing station, with speaker microphones so located that the operator can communicate with individual landing stations during hoist use.
 - (xv) When sinking shafts 75 feet (22.86 m) or less in depth, cages, skips, and buckets that may swing, bump, or snag against shaft sides or other structural protrusions shall be guided by fenders, rails, ropes, or a combination of those means.
 - (xvi) When sinking shafts more than 75 feet (22.86 m) in depth, all cages, skips, and buckets shall be rope or rail-guided to within a rail length from the sinking operation.

- (xvii) Cages, skips, and buckets in all completed shafts, or in all shafts being used as completed shafts, shall be rope or rail-guided for the full length of their travel.
- (xviii) Wire rope used in load lines of material hoists shall be capable of supporting, without failure, at least five times the maximum intended load or the factor recommended by the rope manufacturer, whichever is greater. Refer to §1926.552(c)(14)(iii) of this part for design factors for wire rope used in personnel hoists. The design factor shall be calculated by dividing the breaking strength of wire rope, as reported in the manufacturer's rating tables, by the total static load, including the weight of the wire rope in the shaft when fully extended.
- (xix) A competent person shall visually check all hoisting machinery, equipment, anchorages, and hoisting rope at the beginning of each shift and during hoist use, as necessary.
- (xx) Each safety device shall be checked by a competent person at least weekly during hoist use to ensure suitable operation and safe condition.
- (xxi) In order to ensure suitable operation and safe condition of all functions and safety devices, each hoist assembly shall be inspected and load-tested to 100 percent of its rated capacity: at the time of installation; after any repairs or alterations affecting its structural integrity; after the operation of any safety device; and annually when in use. The employer shall prepare a certification record that includes the date each inspection and load-test was performed; the signature of the person who performed the inspection and test; and a serial number or other identifier for the hoist that was inspected and tested. The most recent certification record shall be maintained on file until completion of the project.
- (xxii) Before hoisting personnel or material, the operator shall perform a test run of any cage or skip whenever it has been out of service for one complete shift, and whenever the assembly or components have been repaired or adjusted.
- (xxiii) Unsafe conditions shall be corrected before using the equipment.
- (4) Additional requirements for personnel hoists.
 - (i) Hoist drum systems shall be equipped with at least two means of stopping the load, each of which shall be capable of stopping and holding 150 percent of the hoist's rated line pull. A broken-rope safety, safety catch, or arrestment device is not a permissible means of stopping under this paragraph.
 - (ii) The operator shall remain within sight and sound of the signals at the operator's station.
 - (iii) All sides of personnel cages shall be enclosed by one-half inch (12.70 mm) wire mesh (not less than No. 14 gauge or equivalent) to a height of not less than 6 feet (1.83 m). However, when the cage or skip is being used as a work platform, its sides may be reduced in height to 42 inches (1.07 m) when the conveyance is not in motion.
 - (iv) All personnel cages shall be provided with positive locking door that does not open outward.
 - (v) All personnel cages shall be provided with a protective canopy. The canopy shall be made of steel plate, at least 3/16-inch (4.763 mm) in thickness, or material of equivalent strength and impact resistance. The canopy shall be sloped to the outside, and so designed that a section may be readily pushed upward to afford emergency egress. The canopy shall cover the top in such a manner as to protect those inside from objects falling in the shaft.
 - (vi) Personnel platforms operating on guide rails or guide ropes shall be equipped with broken-rope safety devices, safety catches or arrestment devices that will stop and hold 150 percent of the weight of the personnel platform and its maximum rated load.
 - (vii) During sinking operations in shafts where guides and safeties are not yet used, the travel speed of the personnel platform shall not exceed 200 feet (60.96 m) per minute. Governor controls set for 200 feet (60.96 m) per minute shall be installed in the control system and shall be used during personnel hoisting.
 - (viii) The personnel platform may travel over the controlled length of the hoistway at rated speeds up to 600 feet (182.88 m) per minute during sinking operations in shafts where guides and safeties are used.

- (ix) The personnel platform may travel at rated speeds greater than 600 feet (182.88 m) per minute in completed shafts.

(u) Definitions.

Accept--Any device, equipment, or appliance that is either approved by MSHA and maintained in permissible condition, or is listed or labeled for the class and location under Subpart K of this part.

Rapid Excavation Machine--Tunnel boring machines, shields, roadheaders, or any other similar excavation machine.

§1926.801 Caissons.

- (a) Wherever, in caisson work in which compressed air is used, and the working chamber is less than 11 feet in length, and when such caissons are at any time suspended or hung while work is in progress so that the bottom of the excavation is more than 9 feet below the deck of the working chamber, a shield shall be erected therein for the protection of the employees.
- (b) Shafts shall be subjected to a hydrostatic or air-pressure test, at which pressure they shall be tight. The shaft shall be stamped on the outside shell about 12 inches from each flange to show the pressure to which they have been subjected.
- (c) Whenever a shaft is used, it shall be provided, where space permits, with a safe, proper, and suitable staircase for its entire length, including landing platforms, not more than 20 feet apart. Where this is impracticable, suitable ladders shall be installed with landing platforms located about 20 feet apart to break the climb.
- (d) All caissons having a diameter or side greater than 10 feet shall be provided with a man lock and shaft for the exclusive use of employees.
- (e) In addition to the gauge in the locks, an accurate gauge shall be maintained on the outer and inner side of each bulkhead. These gauges shall be accessible at all times and kept in accurate working order.
- (f) In caisson operations where employees are exposed to compressed air working environments, the requirements contained in §1926.803 shall be complied with.

§1926.802 Cofferdams.

- (a) If overtopping of the cofferdam by high waters is possible, means shall be provided for controlled flooding of the work area.
- (b) Warning signals for evacuation of employees in case of emergency shall be developed and posted.
- (c) Cofferdam walkways, bridges, or ramps with at least two means of rapid exit shall be provided with guardrails as specified in Subpart M of this part.
- (d) Cofferdams located close to navigable shipping channels shall be protected from vessels in transit, where possible.

§1926.803 Compressed air.**(a) General provisions.**

- (1) There shall be present, at all times, at least one competent person designated by and representing the employer, who shall be familiar with this subpart in all respects, and responsible for full compliance with these and other applicable subparts.
- (2) Every employee shall be instructed in the rules and regulations that concern his safety or the safety of others.

(b) Medical attendance, examination, and regulations.

- (1) There shall be retained one or more licensed physicians familiar with and experienced in the physical requirements and the medical aspects of compressed air work and the treatment of decompression illness. He shall be available at all times while work is in progress in order to provide medical supervision of employees employed in compressed air work. He shall himself be physically qualified and be willing to enter a pressurized environment.
- (2) No employee shall be permitted to enter a compressed air environment until he has been examined by the physician and reported by him to be physically qualified to engage in such work.
- (3) In the event an employee is absent from work for 10 days, or is absent due to sickness or injury, he shall not resume work until he is reexamined by the physician, and his physical condition reported, as provided in this paragraph, to be such as to permit him to work in compressed air.
- (4) After an employee has been employed continuously in compressed air for a period designated by the physician, but not to exceed 1 year, he shall be reexamined by the physician to determine if he is still physically qualified to engage in compressed air work.
- (5) Such physician shall at all times keep a complete and full record of examinations made by him. The physician shall also keep an accurate record of any decompression illness or other illness or injury incapacitating any employee for work, and of all loss of life that occurs in the operation of a tunnel, caisson, or other compartment in which compressed air is used.
- (6) Records shall be available for the inspection of the Secretary or his representatives, and a copy thereof shall be forwarded to OSHA within 48 hours following the occurrence of the accident, death, injury, or decompression illness. It shall state as fully as possible the cause of said death or decompression illness, and the place where the injured or sick employee was taken, and such other relative information as may be required by the Secretary.
- (7) A fully equipped first aid station shall be provided at each tunnel project regardless of the number of persons employed. An ambulance or transportation suitable for a litter case shall be at each project.
- (8) Where tunnels are being excavated from portals more than 5 road miles apart, a first aid station and transportation facilities shall be provided at each portal.
- (9) A medical lock shall be established and maintained in immediate working order whenever air pressure in the working chamber is increased above the normal atmosphere.
- (10) The medical lock shall:
 - (i) Have at least 6 feet of clear headroom at the center, and be subdivided into not less than two compartments;
 - (ii) Be readily accessible to employees working under compressed air;
 - (iii) Be kept ready for immediate use for at least 5 hours subsequent to the emergence of any employee from the working chamber;
 - (iv) Be properly heated, lighted and ventilated;
 - (v) Be maintained in a sanitary condition;
 - (vi) Have a nonshatterable port through which the occupant(s) may be kept under constant observation;
 - (vii) Be designed for a working pressure of 75 p.s.i.g.
 - (viii) Be equipped with internal controls which may be overridden by external controls;
 - (ix) Be provided with air pressure gauges to show the air pressure within each compartment to observers inside and outside the medical lock.
 - (x) Be equipped with a manual type sprinkler system that can be activated inside the lock or by the outside lock tender.
 - (xi) Be provided with oxygen lines and fittings leading into external tanks. The lines shall

- be fitted with check valves to prevent reverse flow. The oxygen system inside the chamber shall be of a closed circuit design and be so designed as to automatically shut off the oxygen supply whenever the fire system is activated.
- (xii) Be in constant charge of an attendant under the direct control of the retained physician. The attendant shall be trained in the use of the lock and suitably instructed regarding steps to be taken in the treatment of employee exhibiting symptoms compatible with a diagnosis of decompression illness;
- (xiii) Be adjacent to an adequate emergency medical facility;
- (xiv) The medical facility shall be equipped with demand-type oxygen inhalation equipment approved by the U.S. Bureau of Mines;
- (xv) Be capable of being maintained at a temperature, in use, not to exceed 90°F nor be less than 70°F; and
- (xvi) Be provided with sources of air, free of oil and carbon monoxide, for normal and emergency use, which are capable of raising the air pressure in the lock from 0 to 75 p.s.i.g. in 5 minutes.
- (11) Identification badges shall be furnished to all employees, indicating that the wearer is a compressed air worker. A permanent record shall be kept of all identification badges issued. The badge shall give the employee's name, address of the medical lock, the telephone number of the licensed physician for the compressed air project, and contain instructions that in case of emergency of unknown or doubtful cause or illness, the wearer shall be rushed to the medical lock. The badge shall be worn at all times--off the job, as well as on the job.
- (c) Telephone and signal communication.
 - (1) Effective and reliable means of communication, such as bells, whistles, or telephones, shall be maintained, at all times between all the following locations:
 - (i) The working chamber face;
 - (ii) The working chamber side of the man lock near the door;
 - (iii) The interior of the man lock;
 - (iv) Lock attendant's station;
 - (v) The compressor plant;
 - (vi) The first-aid station;
 - (vii) The emergency lock (if one is required); and
 - (viii) The special decompression chamber (if one is required).
- (d) Signs and records.
 - (1) The time of decompression shall be posted in each man lock as follows:

TIME OF DECOMPRESSION FOR THIS LOCK

pounds____to____pounds in____minutes.
 pounds____to____pounds in____minutes.
 Signed by)_____(Superintendent)

This form shall be posted in the Man Lock at all times.

- (2) Any code of signals used shall be conspicuously posted near workplace entrances and such other locations as may be necessary to bring them to the attention of all employees concerned.
- (3) For each 8-hour shift, a record of employees employed under air pressure shall be kept by an employee who shall remain outside the lock near the entrance. This record shall show the period each employee spends in the air chamber and the time taken from decompression. A copy shall be submitted to the appointed physician after each shift.
- (e) Compression.
 - (1) Every employee going under air pressure for the first time shall be instructed on how to avoid excessive discomfort.
 - (2) During the compression of employees, the pressure shall not be increased to more than 3 p.s.i.g. within the first minute. The pressure shall be held at 3 p.s.i.g. and again at 7 p.s.i.g. sufficiently long to determine if any employees are experiencing discomfort.
 - (3) After the first minute the pressure shall be raised uniformly and at a rate not to exceed 10 p.s.i.

- per minute.
- (4) If any employee complains of discomfort, the pressure shall be held to determine if the symptoms are relieved. If, after 5 minutes the discomfort does not disappear, the lock attendant shall gradually reduce the pressure until the employee signals that the discomfort has ceased. If he does not indicate that the discomfort has disappeared, the lock attendant shall reduce the pressure to atmospheric and the employee shall be released from the lock.
 - (5) No employee shall be subjected to pressure exceeding 50 pounds per square inch except in emergency.
- (f) Decompression.
- (1) Decompression to normal condition shall be in accordance with the Decompression Tables in Appendix A of this subpart.
 - (2) In the event it is necessary for an employee to be in compressed air more than once in a 24-hour period, the appointed physician shall be responsible for the establishment of methods and procedures of decompression applicable to repetitive exposures.
 - (3) If decanting is necessary, the appointed physician shall establish procedures before any employee is permitted to be decompressed by decanting methods. The period of time that the employees spend at atmospheric pressure between the decompression following the shift and recompression shall not exceed 5 minutes.
- (g) Man locks and special decompression chambers
- (1) Man locks.
 - (i) Except in emergency, no employees employed in compressed air shall be permitted to pass from the working chamber to atmospheric pressure until after decompression, in accordance with the procedures in this subpart.
 - (ii) The lock attendant in charge of a man lock shall be under the direct supervision of the appointed physician. He shall be stationed at the lock controls on the free air side during the period of compression and decompression and shall remain at the lock control station whenever there are men in the working chamber or in the man lock.
 - (iii) Except where air pressure in the working chamber is below 12 p.s.i.g., each man lock shall be equipped with automatic controls which, through taped programs, cams, or similar apparatus, shall automatically regulate decompressions. It shall also be equipped with manual controls to permit the lock attendant to override the automatic mechanism in the event of an emergency, as provided in paragraph (g)(1)(viii) of this section.
 - (iv) A manual control, which can be used in the event of an emergency, shall be placed inside the man lock.
 - (v) A clock, thermometer, and continuous recording pressure gauge with a 4-hour graph shall be installed outside of each man lock and shall be changed prior to each shift's decompression. The chart shall be of sufficient size to register a legible record of variations in pressure within the man lock and shall be visible to the lock attendant. A copy of each graph shall be submitted to the appointed physician after each shift. In addition, a pressure gauge, clock, and thermometer shall also be installed in each man lock. Additional fittings shall be provided so that test gauges may be attached whenever necessary.
 - (vi) Except where air pressure is below 12 p.s.i.g. and there is no danger of rapid flooding, all caissons having a working area greater than 150 square feet, and each bulkhead in tunnels of 14 feet or more in diameter, or equivalent area, shall have at least two locks in perfect working condition, one of which shall be used exclusively as a man lock, the other, as a materials lock.
 - (vii) Where only a combination man-and-materials lock is required, this single lock shall be of sufficient capacity to hold the employees constituting two successive shifts.
 - (viii) Emergency locks shall be large enough to hold an entire heading shift and a limit maintained of 12 p.s.i.g. There shall be a chamber available for oxygen decompression therapy to 28 p.s.i.g.
 - (ix) The man lock shall be large enough so that those using it are not compelled to be in a cramped position, and shall not have less than 5 feet clear head room at the center and a minimum of 30 cubic feet of air space per occupant.

- (x) Locks on caissons shall be so located that the bottom door shall be not less than 3 feet above the water level surrounding the caisson on the outside. (The water level, where it is affected by tides, is construed to mean high tide.)
- (xi) In addition to the pressure gauge in the locks, an accurate pressure gauge shall be maintained on the outer and inner side of each bulkhead. These gauges shall be accessible at all times and shall be kept in accurate working order.
- (xii) Man locks shall have an observation port at least 4 inches in diameter located in such a position that all occupants of the man lock may be observed from the working chamber and from the free air side of the lock.
- (xiii) Adequate ventilation in the lock shall be provided.
- (xiv) Man locks shall be maintained at a minimum temperature of 70°F.
- (xv) When locks are not in use and employees are in the working chamber, lock doors shall be kept open to the working chamber, where practicable.
- (xvi) Provision shall be made to allow for rescue parties to enter the tunnel if the working force is disabled.
- (xvii) A special decompression chamber of sufficient size to accommodate the entire force of employees being decompressed at the end of a shift shall be provided whenever the regularly established working period requires a total time of decompression exceeding 75 minutes.
- (2) Special decompression chamber.
 - (i) The headroom in the special decompression chamber shall be not less than a minimum 7 feet and the cubical content shall provide at least 50 cubic feet of airspace for each employee. For each occupant, there shall be provided 4 square feet of free walking area and 3 square feet of seating space, exclusive of area required for lavatory and toilet facilities. The rated capacity shall be based on the stated minimum space per employee and shall be posted at the chamber entrance. The posted capacity shall not be exceeded, except in case of emergency.
 - (ii) Each special decompression chamber shall be equipped with the following:
 - (a) A clock or clocks suitably placed so that the attendant and the chamber occupants can readily ascertain the time;
 - (b) Pressure gauges that will indicate to the attendants and to the chamber occupants the pressure in the chamber;
 - (c) Valves to enable the attendant to control the supply and discharge of compressed air into and from the chamber;
 - (d) Valves and pipes, in connection with the air supply and exhaust, arranged so that the chamber pressure can be controlled from within and without;
 - (e) Effective means of oral intercommunication between the attendant, occupants of the chamber, and the air compressor plant; and
 - (f) An observation port at the entrance to permit observation of the chamber occupants.
 - (iii) Seating facilities in special decompression chambers shall be so arranged as to permit a normal sitting posture without cramping. Seating space, not less than 18 inches by 24 inches wide, shall be provided per occupant.
 - (iv) Adequate toilet and washing facilities, in a screened or enclosed recess, shall be provided. Toilet bowls shall have a built-in protector on the rim so that an air space is created when the seat lid is closed.
 - (v) Fresh and pure drinking water shall be available. This may be accomplished by either piping water into the special decompression chamber and providing drinking fountains, or by providing individual canteens, or by some other sanitary means. Community drinking vessels are prohibited.
 - (vi) No refuse or discarded material of any kind shall be permitted to accumulate, and the chamber shall be kept clean.
 - (vii) Unless the special decompression chamber is serving as the man lock to atmospheric pressure, the special decompression chamber shall be situated, where practicable, adjacent to the man lock on the atmospheric pressure side of the bulkhead. A passageway shall be provided, connecting the special chamber with the man lock, to

permit employees in the process of decompression to move from the man lock to the special chamber without a reduction in the ambient pressure from that designated for the next stage of decompression. The passageway shall be so arranged as to not interfere with the normal operation of the man lock, nor with the release of the occupants of the special chamber to atmospheric pressure upon the completion of the decompression procedure.

(h) Compressor plant and air supply.

- (1) At all times there shall be a thoroughly experienced, competent, and reliable person on duty at the air control valves as a gauge tender who shall regulate the pressure in the working areas. During tunneling operations, one gauge tender may regulate the pressure in not more than two headings: Provided that the gauge and controls are all in one location. In caisson work, there shall be a gauge tender for each caisson.
- (2) The low air compressor plant shall be of sufficient capacity to not only permit the work to be done safely, but shall also provide a margin to meet emergencies and repairs.
- (3) Low air compressor units shall have at least two independent and separate sources of power supply and each shall be capable of operating the entire low air plant and its accessory systems.
- (4) The capacity, arrangement, and number of compressors shall be sufficient to maintain the necessary pressure without overloading the equipment and to assure maintenance of such pressure in the working chamber during periods of breakdown, repair, or emergency.
- (5) Switching from one independent source of power supply to the other shall be done periodically to ensure the workability of the apparatus in an emergency.
- (6) Duplicate low-pressure air feedlines and regulating valves shall be provided between the source of air supply and a point beyond the locks with one of the lines extending to within 100 feet of the working face.
- (7) All high- and low-pressure air supply lines shall be equipped with check valves.
- (8) Low-pressure air shall be regulated automatically. In addition, manually operated valves shall be provided for emergency conditions.
- (9) The air intakes for all air compressors shall be located at a place where fumes, exhaust, gases, and other air contaminants will be at a minimum.
- (10) Gauges indicating the pressure in the working chamber shall be installed in the compressor building, the lock attendant's station, and at the employer's field office.

(i) Ventilation and air quality.

- (1) Exhaust valves and exhaust pipes shall be provided and operated so that the working chamber shall be well ventilated, and there shall be no pockets of dead air. Outlets may be required at intermediate points along the main low-pressure air supply line to the heading to eliminate such pockets of dead air. Ventilating air shall be not less than 30 cubic feet per minute.
- (2) The air in the workplace shall be analyzed by the employer not less than once each shift, and records of such tests shall be kept on file at the place where the work is in progress. The test results shall be within the threshold limit values specified in Subpart D of this part, for hazardous gases, and within 10 percent of the lower explosive limit of flammable gases. If these limits are not met, immediate action to correct the situation shall be taken by the employer.
- (3) The temperature of all working chambers that are subjected to air pressure shall, by means of after-coolers or other suitable devices, be maintained at a temperature not to exceed 85°F.
- (4) Forced ventilation shall be provided during decompression. During the entire decompression period, forced ventilation through chemical or mechanical air purifying devices that will ensure a source of fresh air shall be provided.
- (5) Whenever heat-producing machines (moles, shields) are used in compressed air tunnel operations, a positive means of removing the heat buildup at the heading shall be provided.

(j) Electricity.

- (1) All lighting in compressed-air chambers shall be by electricity exclusively, and two independent electric-lighting systems with independent sources of supply shall be used. The emergency source shall be arranged to become automatically operative in the event of failure of the regularly used source.

- (2) The minimum intensity of light on any walkway, ladder, stairway, or working level shall be not less than 10-foot candles, and in all workplaces the lighting shall at all times be such as to enable employees to see clearly.
 - (3) All electrical equipment and wiring for light and power circuits shall comply with the requirements of Subpart K of this part for use in damp, hazardous, high temperature, and compressed air environments.
 - (4) External parts of lighting fixtures and all other electrical equipment, when within 8 feet of the floor, shall be constructed of noncombustible, non-absorptive, insulating materials, except that metal may be used if it is effectively grounded.
 - (5) Portable lamps shall be equipped with noncombustible, non-absorptive, insulating sockets, approved handles, basket guards, and approved cords.
 - (6) The use of worn or defective portable and pendant conductors is prohibited.
- (k) Sanitation.**
- (1) Sanitary, heated, lighted, and ventilated dressing rooms and drying rooms shall be provided for all employees engaged in compressed air work. Such rooms shall contain suitable benches and lockers. Bathing accommodations (showers at the ratio of one to 10 employees per shift), equipped with running hot and cold water, and suitable and adequate toilet accommodations, shall be provided. One toilet for each 15 employees, or fractional part thereof, shall be provided.
 - (2) When the toilet bowl is shut by a cover, there should be an air space so that the bowl or bucket does not implode when pressure is increased.
 - (3) All parts of caissons and other working compartments shall be kept in a sanitary condition.
- (l) Fire prevention and protection.**
- (1) Firefighting equipment shall be available at all times and shall be maintained in working condition.
 - (2) While welding or flame-cutting is being done in compressed air, a firewatch with a fire hose or approved extinguisher shall stand by until such operation is completed.
 - (3) Shafts and caissons containing flammable material of any kind, either above or below ground, shall be provided with a waterline and a fire hose connected thereto, so arranged that all points of the shaft or caisson are within reach of the hose stream.
 - (4) Fire hose shall be at least 1 1/2 inches in nominal diameter; the water pressure shall at all times be adequate for efficient operation of the type of nozzle used; and the water supply shall be such as to ensure an uninterrupted flow. Fire hose, when not in use, shall be located or guarded to prevent injury thereto.
 - (5) The power house, compressor house, and all buildings housing ventilating equipment, shall be provided with at least one hose connection in the water line, with a fire hose connected thereto. A fire hose shall be maintained within reach of structures of wood over or near shafts.
 - (6) Tunnels shall be provided with a 2-inch minimum diameter water line extending into the working chamber and to within 100 feet of the working face. Such line shall have hose outlets with 100 feet of fire hose attached and maintained as follows: One at the working face; one immediately inside of the bulkhead of the working chamber; and one immediately outside such bulkhead. In addition, hose outlets shall be provided at 200-foot intervals throughout the length of the tunnel, and 100 feet of fire hose shall be attached to the outlet nearest to any location where flammable material is being kept or stored or where any flame is being used.
 - (7) In addition to fire hose protection required by this subpart, on every floor of every building not under compressed air, but used in connection with the compressed air work, there shall be provided at least one approved fire extinguisher of the proper type for the hazard involved. At least two approved fire extinguishers shall be provided in the working chamber as follows: One at the working face and one immediately inside the bulkhead (pressure side). Extinguishers in the working chamber shall use water as the primary extinguishing agent and shall not use any extinguishing agent that could be harmful to the employees in the working chamber. The fire extinguisher shall be protected from damage.
 - (8) Highly combustible materials shall not be used or stored in the working chamber. Wood, paper, and similar combustible material shall not be used in the working chamber in quantities that could cause a fire hazard. The compressor building shall be constructed of non-combustible material.

- (9) Man locks shall be equipped with a manual type fire extinguisher system that can be activated inside the man lock and also by the outside lock attendant. In addition, a fire hose and portable fire extinguisher shall be provided inside and outside the man lock. The portable fire extinguisher shall be the dry chemical type.
 - (10) Equipment, fixtures, and furniture in man locks and special decompression chambers shall be constructed of noncombustible materials. Bedding, etc., shall be chemically treated so as to be fire resistant.
 - (11) Head frames shall be constructed of structural steel or open framework fireproofed timber. Head houses and other temporary surface buildings or structures within 100 feet of the shaft, caisson, or tunnel opening shall be built of fire-resistant materials.
 - (12) No oil, gasoline, or other combustible material shall be stored within 100 feet of any shaft, caisson, or tunnel opening, except that oils may be stored in suitable tanks in isolated fireproof buildings, provided such buildings are not less than 50 feet from any shaft, caisson, or tunnel opening, or any building directly connected thereto.
 - (13) Positive means shall be taken to prevent leaking flammable liquids from flowing into the areas specifically mentioned in the preceding paragraph.
 - (14) All explosives used in connection with compressed air work shall be selected, stored, transported, and used as specified in Subpart U of this part.
- (m) Bulkheads and safety screens.**
- (1) Intermediate bulkheads with locks, or intermediate safety screens or both, are required where there is the danger of rapid flooding.
 - (2) In tunnels 16 feet or more in diameter, hanging walkways shall be provided from the face to the man lock as high in the tunnel as practicable, with at least 6 feet of head room. Walkways shall be constructed of noncombustible material. Standard railings shall be securely installed throughout the length of all walkways on open sides in accordance with Subpart M of this part. Where walkways are ramped under safety screens, the walkway surface shall be skidproofed by cleats or by equivalent means.
 - (3) Bulkheads used to contain compressed air shall be tested, where practicable, to prove their ability to resist the highest air pressure which may be expected to be used.

§1926.804 Definitions applicable to this subpart.

- (a) **Bulkhead**--An airtight structure separating the working chamber from free air or from another chamber under a lesser pressure than the working pressure.
- (b) **Caisson**--A wood, steel, concrete or reinforced concrete, air- and water-tight chamber in which it is possible for men to work under air pressure greater than atmospheric pressure to excavate material below water level.
- (c) **Decanting**--A method used for decompressing under emergency circumstances. In this procedure, the employees are brought to atmospheric pressure with a very high gas tension in the tissues and then immediately recompressed in a second and separate chamber or lock.
- (d) **Emergency locks**--A lock designed to hold and permit the quick passage of an entire shift of employees.
- (e) **High air**--Air pressure used to supply power to pneumatic tools and devices.
- (f) **Low air**--Air supplied to pressurize working chambers and locks.
- (g) **Man lock**--A chamber through which men pass from one air pressure environment into another.
- (h) **Materials lock**--A chamber through which materials and equipment pass from one air pressure environment into another.
- (i) **Medical lock**--A special chamber in which employees are treated for decompression illness. It may also be used in pre-employment physical examinations to determine the adaptability of the prospective employee to changes in pressure.
- (j) **Normal condition**--One during which exposure to compressed air is limited to a single continuous working period followed by a single decompression in any given 24-hour period; the total time of exposure to compressed air during the single continuous working period is not interrupted by exposure to normal atmospheric pressure, and a second exposure to compressed air does not occur until at least 12 consecutive hours of exposure to normal atmospheric pressure has elapsed since the employee has been under pressure.
- (k) **Pressure**--A force acting on a unit area. Usually shown as pounds per square inch. (p.s.i.)
- (l) **Absolute pressure** (p.s.i.a.)--The sum of the atmospheric pressure and gauge pressure (p.s.i.g.).
- (m) **Atmospheric pressure**--The pressure of air at sea level, usually 14.7 p.s.i.a. (1 atmosphere), or 0 p.s.i.g.
- (n) **Gauge pressure** (p.s.i.g.)--Pressure measured by a gauge and indicating the pressure exceeding atmospheric.
- (o) **Safety screen**--An air- and water-tight diaphragm placed across the upper part of a compressed air tunnel between the face and bulkhead, in order to prevent flooding the crown of the tunnel between the safety screen and the bulkhead, thus providing a safe means of refuge and exit from a flooding or flooded tunnel.
- (p) **Special decompression chamber**--A chamber to provide greater comfort of employees when the total decompression time exceeds 75 minutes.
- (q) **Working chamber**--The space or compartment under air pressure in which the work is being done.

APPENDIX A TO SUBPART S - DECOMPRESSION TABLES

1. Explanation. The decompression tables are computed for working chamber pressures from 0 to 14 pounds, and from 14 to 50 pounds per square inch gauge inclusive by 2-pound increments and for exposure times for each pressure extending from one-half to over 8 hours inclusive.

Decompressions will be conducted by two or more stages with a maximum of four stages, the latter for a working chamber pressure of 40 pounds per square inch gauge or over.

Stage 1 consists of a reduction in ambient pressure ranging from 10 to a maximum of 16 pounds per square inch, but in no instance will the pressure be reduced below 4 pounds at the end of stage 1. This reduction in pressure in stage 1 will always take place at a rate not greater than 5 pounds per minute.

Further reduction in pressure will take place during stage 2 and subsequent stages as required at a slower rate, but in no event at a rate greater than 1 pound per minute.

Decompression Table No. 1 indicates in the body of the table the total decompression time in minutes for various combinations of working chamber pressure and exposure time.

Decompression Table No. 2 indicates for the same various combinations of working chamber pressure and exposure time the following:

- a. The number of stages required;
- b. The reduction in pressure and the terminal pressure for each required stage;
- c. The time in minutes through which the reduction in pressure is accomplished for each required stage;
- d. The pressure reduction rate in minutes per pound for each required stage;

IMPORTANT NOTE: The Pressure Reduction in Each Stage is Accomplished at a Uniform Rate. Do Not Interpolate Between Values Shown on the Tables. Use the Next Higher Value of Working Chamber Pressure or Exposure Time Should the Actual Working Chamber Pressure or the Actual Exposure Time, Respectively, Fall Between Those for Which Calculated Values are Shown in the Body of the Tables.

Examples	Minutes
Example No. 1: 4 hours working period at 20 pounds gauge. Decompression Table No. 1: 20 pounds for 4 hours total decompression time.....	43
Decompression Table No. 2: Stage 1: Reduce pressure from 20 pounds to 4 pounds at the uniform rate of 5 pounds per minute. Elapsed time stage 1: 16/5.....	3
Stage 2 (final stage): Reduce pressure at a uniform rate from 4 pounds to 0-pound gage over a period of 40 minutes. Rate--0.10 pound per minute or 10 minutes per pound. Stage 2 (final) elapsed time.....	40
Total Time	43
Example No. 2: 5-hour working period at 24 hour pounds gage. Decompression Table No. 1: 24 pounds for 5 hours, total decompression time.....	117
Decompression Table No. 2: Stage 1: Reduce pressure from 24 pounds to 8 pounds at the uniform rate of 5 pounds per minute. Elapsed time stage 1: 16/5.....	3
Stage 2: Reduce pressure at a uniform rate from 8 pounds to 4 pounds over a period of 4 minutes. Rate, 1 pound per minute Elapsed time, stage 2.....	4
Transfer men to special decompression chamber maintaining the 4-pound pressure during the transfer operation. Stage 3 (final stage): In the special decompression chamber, reduce the pressure at a uniform rate from 4 pounds to 0-pound gage over a period of 110 minutes. Rate, 0.037 pound per minute or 27.5 minutes per pound. Stage 3 (final) elapsed time.....	110
Total Time	1 17

DECOMPRESSION TABLE NO. 1 - TOTAL DECOMPRESSION TIME

Work pressure p.s.i.g	Working period hours										
	1/2	1	1_1/2	2	3	4	5	6	7	8	Over 8
9 to 12.	3	3	3	3	3	3	3	3	3	3	3
14.....	6	6	6	6	6	6	6	6	16	16	33
16.....	7	7	7	7	7	7	17	33	48	48	62
18.....	7	7	7	8	11	17	48	63	63	73	87
20.....	7	7	8	15	15	43	63	73	83	103	113
22.....	9	9	16	24	38	68	93	103	113	128	133
24.....	11	12	23	27	52	92	117	122	127	137	151
26.....	13	14	29	34	69	104	126	141	142	142	163
28.....	15	23	31	41	98	127	143	153	153	165	183
30.....	17	28	38	62	105	143	165	168	178	188	204
32.....	19	35	43	85	126	163	178	193	203	213	226
34.....	21	39	58	98	151	178	195	218	223	233	248
36.....	24	44	63	113	170	198	223	233	243	253	273
38.....	28	49	73	128	178	203	223	238	253	263	278
40.....	31	49	84	143	183	213	233	248	258	278	288
42.....	37	56	102	144	189	215	245	260	263	268	293
44.....	43	64	118	154	199	234	254	264	269	269	293
46.....	44	74	139	171	214	244	269	274	289	299	318
48.....	51	89	144	189	229	269	299	309	319	319	...
50.....	58	94	164	209	249	279	309	329	...	...	...

DECOMPRESSION TABLE NO. 2

[Do not interpolate, use next higher value for conditions not computed]

Working chamber pressure p.s.i.g.	Working period hours	Decompression Data					
		Stage No.	Pressure reduce. P.s.i.g.		Time in stage minutes	Pressure reduce. Rate Min/pound	Total time decompress minutes
			From	To			
14.....	1/2	1	14	4	2	0.20	6
		2	4	0	4	1.00	6
	1	1	14	4	2	0.20	6
		2	4	0	4	1.00	6
	1 1/2	1	14	4	2	0.20	6
		2	4	0	4	1.00	6
	2	1	14	4	2	0.20	6
		2	4	0	4	1.00	6
	3	1	14	4	2	0.20	6
		2	4	0	4	1.00	6
	4	1	14	0	2	0.20	6
		2	4	0	4	1.00	6
	5	1	14	4	2	0.20	6
		2	4	0	4	1.00	6
	6	1	14	4	2	0.20	.....
		2	4	0	4	1.00	6
	7	1	14	4	2	0.20	.....
		2	4	0	14	3.50	16
	8	1	14	4	2	0.20	.....
		2	4	0	14	3.50	16
	Over 8	1	14	4	2	0.20	.....
		2	4	0	30	7.50	32
16.....	1/2	1	16	4	3	0.20	.....
		2	4	0	4	1.00	7
	1	1	16	4	3	0.20	7
		2	4	0	4	1.00	7
	1 1/2	1	16	4	3	0.20	.....
		2	4	0	4	1.00	7
	2	1	16	4	3	0.20	.....
		2	4	0	4	1.00	7
	3	1	16	4	3	0.20	.....
		2	4	0	4	1.00	7

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

	4	1	14	4	3	0.20	.....
		2	4	0	4	1.00	7
	5	1	14	4	3	0.20	7
		2	4	0	4	3.5	17
	6	1	14	4	3	0.20	.....
		2	4	0	30	7.50	33
	7	1	14	4	3	0.20	.....
		2	4	0	45	11.25	48
	8	1	14	4	3	0.20	.....
		2	4	0	45	11.25	48
	Over 8	1	14	4	3	0.20	.....
		2	4	0	45	15.00	63
18.....	1/2	1	18	4	3	0.20	.....
		2	4	0	4	1.00	7
	1	1	18	4	3	0.20	.....
		2	4	0	4	1.00	7
	1 1/2	1	18	4	3	0.20	.....
		2	4	0	4	1.00	7
	2	1	18	4	3	0.20	.....
		2	4	0	5	1.25	8
	3	1	18	4	3	0.20	.....
		2	4	0	8	2.00	11
	4	1	18	4	3	0.20	.....
		2	4	0	14	3.50	17
	5	1	18	4	3	0.20	.....
		2	4	0	45	11.25	48
	6	1	18	4	3	0.20	.....
		2	4	0	60	15.00	63
	7	1	18	4	3	0.20	.....
		2	4	0	60	15.00	63
	8	1	18	4	3	0.20	.....
		2	4	0	70	17.50	73

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

	Over 8	1	18	4	3	0.20	.....
		2	4	0	84	21.00	87
20.....	1/2	1	20	4	3	0.20	.....
		2	4	0	4	1.00	7
	1	1	20	4	3	0.20	.....
		2	4	0	4	1.00	7
	1 1/2	1	20	4	3	0.20	.....
		2	4	0	5	1.25	8
	2	1	20	4	3	0.20	.....
		2	4	0	12	3.00	15
	3	1	20	4	3	0.20	.....
		2	4	0	12	3.00	15
	4	1	20	4	3	0.20	.....
		2	4	0	40	10.00	43
	5	1	20	4	3	0.20	.....
		2	4	0	60	15.00	63
	6	1	20	4	3	0.20	.....
		2	4	0	70	17.5	73
	7	1	20	4	3	0.20	.....
		2	4	0	80	20.00	83
	8	1	20	4	3	0.20	.....
		2	4	0	100	25.00	103
	Over 8	1	20	4	3	0.20	.....
		2	4	0	110	27.5	113
22.....	1/2	1	22	6	3	0.20	.....
		2	6	0	6	1.00	9
	1	1	22	6	3	0.20	.....
		2	6	0	6	1.00	9
	1 1/2	1	22	6	3	0.20	.....
		2	6	0	13	2.20	16
	2	1	22	6	3	0.20	.....
		2	6	0	21	3.50	24

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

	3	1	22	6	3	0.20	.....
		2	6	0	35	5.85	38
	4	1	22	6	3	0.20	.....
		2	6	0	65	10.83	68
	5	1	22	6	3	0.20	.....
		2	6	0	90	15.00	93
	6	1	22	6	3	0.20	.....
		2	4	0	100	16.67	103
	7	1	22	6	3	0.20	.....
		2	6	0	110	18.35	113
	8	1	22	6	3	0.20	.....
		2	6	0	125	20.80	128
	Over 8	1	22	6	3	0.20	.....
		2	6	0	130	21.70	133
24.....	1/2	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	4	1.00	11
	1	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	5	1.25	12
	1 1/2	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	16	4.00	23
	2	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	20	5.00	27
	3	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	45	11.25	52
	4	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	85	21.25	92
	5	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		3	4	0	110	27.50	117
	6	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	115	28.80	122
	7	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	120	30.00	127
	8	1	24	8	3	0.20	.....
		2	8	4	4	1.00	.....
		3	4	0	130	32.50	137
	Over 8	1	24	8	3	0.20	.....
		2	8	4	8	2.00	.....
		3	4	0	140	35.00	151
26.....	1/2	1	26	10	3	0.20	.....
		2	10	4	6	1.00	.....
		3	4	0	4	1.00	13
	1	1	26	10	3	0.20	.....
		2	10	4	6	1.00	.....
		3	4	0	5	1.25	14
	1 1/2	1	26	10	3	0.20	.....
		2	10	4	6	1.00	.....
		3	4	0	20	5.00	29
	2	1	26	10	3	.020	.....
		2	10	4	6	1.00	.....
		3	4	0	25	6.25	34
	3	1	26	10	3	0.20	.....
		2	10	4	6	1.00	.....
		3	4	0	60	15.00	69
	4	1	26	10	3	0.20	.....
		2	10	4	6	1.00	.....
		3	4	0	95	23.75	104
	5	1	26	10	3	0.20	.....
		2	10	4	8	1.33	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		3	4	0	115	28.80	126
	6	1	26	10	3	0.20	.....
		2	10	4	8	1.33	.....
		3	4	0	130	32.50	141
	7	1	26	10	3	2.20	.....
		2	10	4	9	1.50	.....
		3	4	0	130	32.50	142
	8	1	26	10	3	0.20	.....
		2	10	4	9	1.50	.....
		3	4	0	130	32.50	142
	Over 8	1	26	10	3	0.20	.....
		2	10	4	30	5.00	.....
		3	4	0	30	32.50	163
28.....	1/2	1	28	12	3	0.20	.....
		2	12	4	8	1.00	.....
		3	4	0	4	1.00	15
	1	1	28	12	3	0.20	.....
		2	12	4	8	1.00	.....
		3	4	0	12	3.00	23
	1 1/2	1	28	12	3	0.20	.....
		2	12	4	8	1.00	.....
		3	4	0	20	5.00	31
	2	1	28	12	3	0.20	.....
		2	12	4	10	1.25	.....
		3	4	0	30	7.50	41
	3	1	28	12	3	0.20	.....
		2	12	4	10	1.25	.....
		3	4	0	85	21.20	98
	4	1	28	12	3	0.20	.....
		2	12	4	14	1.75	.....
		3	4	0	110	27.50	127
	5	1	28	12	3	0.20	.....
		2	12	4	20	2.50	.....
		3	4	0	120	30.00	143

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

	6	1	30	14	3	0.20	.....
		2	14	4	35	3.50	.....
		3	4	0	130	32.50	168
	7	1	30	14	3	0.20	.....
		2	14	4	45	4.50	.....
		3	4	0	130	32.50	178
	8	1	30	14	3	0.20	.....
		2	14	4	55	5.50	.....
		3	4	0	130	32.50	188
	Over 8	1	30	14	3	0.20	.....
		2	14	4	71	7.10	.....
		3	4	0	130	32.50	204
32.....	1/2	1	32	16	3	0.20	.....
		2	16	4	12	1.00	.....
		3	4	0	4	1.00	19
	1	1	32	16	3	0.20	.....
		2	16	4	12	1.00	.....
		3	4	0	20	5.00	35
	1 1/2	1	32	16	3	0.20	.....
		2	16	4	15	1.25	.....
		3	4	0	25	6.25	43
	2	1	32	16	3	0.20	.....
		2	16	4	22	1.83	.....
		3	4	0	60	15.00	85
	3	1	32	16	3	0.20	.....
		2	16	4	28	2.33	.....
		3	4	0	95	23.75	126
	4	1	32	16	3	0.20	.....
		2	16	4	40	3.33	.....
		3	4	0	120	30.00	163
	5	1	32	16	3	0.20	.....
		2	16	4	45	3.75	.....
		3	4	0	130	32.50	178
	6	1	32	16	3	0.20	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		2	16	4	60	5.00	.....
		3	4	0	130	32.50	193
	7	1	32	16	3	0.20	.....
		2	16	4	70	5.83	.....
		3	4	0	130	32.50	203
	8	1	32	16	3	0.20	.....
		2	16	4	80	6.67	.....
		3	4	0	130	32.50	213
	Over 8	1	32	16	3	0.20	.....
		2	16	4	93	7.75	.....
		3	4	0	130	32.50	226
34.....	1/2	1	34	18	3	0.20	.....
		2	18	4	14	1.00	.....
		3	4	0	4	1.00	21
	1	1	34	18	3	0.20	.....
		2	18	4	14	1.00	.....
		3	4	0	22	5.50	39
	1 1/2	1	34	18	3	0.20	.....
		2	18	4	25	1.80	.....
		3	4	0	30	7.50	58
	2	1	34	18	3	0.20	.....
		2	18	4	35	2.50	.....
		3	4	0	60	15.00	98
	3	1	34	18	3	0.20	.....
		2	18	4	43	3.10	.....
		3	4	0	105	26.25	151
	4	1	34	18	3	0.20	.....
		2	18	4	55	3.93	.....
		3	4	0	120	30.00	178
	5	1	34	18	3	0.20	.....
		2	18	4	62	4.43	.....
		3	4	0	130	32.50	195
	6	1	34	18	3	0.20	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		2	18	4	85	6.07	.....
		3	4	0	130	32.50	218
	7	1	34	18	3	0.20	.....
		2	18	4	90	6.43	.....
		3	4	0	130	32.50	223
	8	1	34	18	3	0.20	.....
		2	18	4	100	7.15	.....
		3	4	0	130	32.50	233
	Over 8	1	34	18	3	0.20	.....
		2	18	4	115	8.23	.....
		3	4	0	130	32.50	248
36.....	1/2	1	36	20	3	0.20	.....
		2	20	4	16	1.00	.....
		3	4	0	5	1.25	24
	1	1	36	20	3	0.20	.....
		2	20	4	16	1.00	.....
		3	4	0	25	6.25	44
	1 1/2	1	36	20	3	0.20	.....
		2	20	4	30	1.88	.....
		3	4	0	30	7.50	63
	2	1	36	20	3	0.20	.....
		2	20	4	40	2.50	.....
		3	4	0	70	17.50	113
	3	1	36	20	3	0.20	.....
		2	20	4	52	3.25	.....
		3	4	0	115	28.5	170
	4	1	36	20	3	0.20	.....
		2	20	4	65	4.06	.....
		3	4	0	130	32.50	198
	5	1	36	20	3	0.20	.....
		2	20	4	90	5.63	.....
		3	4	0	130	32.50	223
	6	1	36	20	3	0.20	.....
		2	20	4	100	6.25	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		3	4	0	130	32.50	233
	7	1	36	20	3	0.20	.....
		2	20	4	110	6.88	.....
		3	4	0	130	32.50	243
	8	1	36	20	3	0.20	.....
		2	20	4	120	7.50	.....
		3	4	0	130	32.50	253
	Over 8	1	36	20	3	0.20	.....
		2	20	4	140	8.75	.....
		3	4	0	130	32.50	273
38.....	1/2	1	38	22	3	0.20	.....
		2	22	6	16	1.00	.....
		3	6	0	9	1.50	28
	1	1	38	22	3	0.20	.....
		2	22	6	16	1.00	.....
		3	6	0	30	5.00	49
	1 1/2	1	38	22	3	0.20	.....
		2	22	6	20	1.25	.....
		3	6	0	50	8.34	73
	2	1	38	22	3	0.20	.....
		2	22	6	30	1.88	.....
		3	6	0	95	15.83	128
	3	1	38	22	3	0.20	.....
		2	22	6	35	2.19	.....
		3	6	0	140	23.35	178
	4	1	38	22	3	0.20	.....
		2	22	6	50	3.12	.....
		3	6	0	150	25.00	203
	5	1	38	22	3	0.20	.....
		2	22	6	55	3.44	.....
		3	6	0	165	27.50	233
	6	1	38	22	3	0.20	.....
		2	22	6	70	4.38	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		3	6	0	165	27.50	238
	7	1	38	22	3	0.20	.....
		2	22	6	85	5.32	.....
		3	6	0	165	27.50	253
	8	1	38	22	3	0.20	.....
		2	22	6	95	5.93	.....
		3	6	0	165	27.50	263
	Over 8	1	38	22	3	0.20	.....
		2	22	6	110	6.88	.....
		3	6	0	165	27.50	278
40.....	1/2	1	40	24	3	0.20	.....
		2	24	8	16	1.00	.....
		3	8	4	4	1.00	.....
		4	4	0	8	2.00	31
	1	1	40	24	3	0.20	.....
		2	24	8	16	1.00	.....
		3	8	4	5	1.25	.....
		4	4	0	25	6.25	49
	1 1/2	1	40	24	3	0.20	.....
		2	24	8	16	1.00	.....
		3	8	4	20	5.00	.....
		4	4	0	45	11.25	84
	2	1	24	8	25	1.56	.....
		2	40	24	3	0.20	.....
		3	8	4	20	5.00	.....
		4	4	0	95	23.75	143
	3	1	40	24	3	0.20	.....
		2	24	8	30	1.88	.....
		3	8	4	30	7.50	.....
		4	4	0	120	30.00	183

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

	4	1	40	24	3	0.20	.....
		2	24	8	45	2.81	.....
		3	8	4	35	8.75	.....
		4	4	0	130	32.50	213
	5	1	40	24	3	0.20	.....
		2	24	8	47	2.94	.....
		3	8	4	53	13.25	.....
		4	4	0	130	32.50	233
	6	1	40	24	3	0.20	.....
		2	24	8	55	3.44	.....
		3	8	4	60	15.00	.....
		4	4	0	130	32.50	248
	7	1	40	24	3	0.20	.....
		2	24	8	65	4.06	.....
		3	8	4	60	15.00	.....
		4	4	0	130	32.50	258
	8	1	40	24	3	0.20	.....
		2	24	8	75	4.70	.....
		3	8	4	60	15.00	.....
		4	4	0	130	32.50	268
	Over 8	1	40	24	3	0.20	.....
		2	24	8	95	5.93	.....
		3	8	4	60	15.00	.....
		4	4	0	130	32.50	288
42.....	1/2	1	42	26	3	0.20	.....
		2	26	10	16	1.00	.....
		3	10	4	6	1.00	.....
		4	4	0	12	3.00	37
	1	1	42	26	3	0.20	.....
		2	26	10	16	1.00	.....
		3	10	4	12	2.00	.....
		4	4	0	25	6.25	56

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

	1 1/2	1	42	26	3	0.20	.....
		2	26	10	16	1.00	.....
		3	10	4	23	3.83	.....
		4	4	0	60	15.00	102
	2	1	42	26	3	0.20	.....
		2	26	10	16	1.00	.....
		3	10	4	30	5.00	.....
		4	4	0	95	23.75	144
	3	1	42	26	3	0.20	.....
		2	26	10	16	1.00	.....
		3	10	4	30	5.00	.....
		4	4	0	120	30.00	189
	4	1	42	26	3	0.20	.....
		2	26	10	17	1.06	.....
		3	10	4	65	10.83	.....
		4	4	0	130	32.50	215
	5	1	42	26	3	0.20	.....
		2	26	10	27	1.69	.....
		3	10	4	85	14.18	.....
		4	4	0	130	32.50	245
	6	1	42	26	3	0.20	.....
		2	26	10	27	1.69	.....
		3	10	4	100	16.67	.....
		4	4	0	130	32.50	260
	7	1	42	26	3	0.20	.....
		2	26	10	30	1.88	.....
		3	10	4	100	16.67	.....
		4	4	0	130	32.50	263
	8	1	42	26	3	0.20	.....
		2	26	10	35	2.19	.....
		3	10	4	100	16.67	.....
		4	4	0	130	32.50	268
	Over 8	1	42	26	3	0.20	.....
		2	26	10	60	3.75	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		3	10	4	100	16.67	.....
		4	4	0	130	32.50	293
44.....	1/2	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	8	1.00	.....
		4	4	0	16	4.00	43
	1	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	20	2.50	.....
		4	4	0	25	6.25	64
	1 1/2	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	27	3.38	.....
		4	4	0	72	18.00	118
	2	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	40	5.00	.....
		4	4	0	95	23.75	154
	3	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	60	7.50	.....
		4	4	0	120	30.00	199
	4	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	85	10.62	.....
		4	4	0	130	32.50	234
	5	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	105	13.13	.....
		4	4	0	130	32.50	254
	6	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	115	14.38	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		4	4	0	130	32.50	264
	7	1	44	28	3	0.20	.....
		2	28	12	16	1.00	.....
		3	12	4	120	15.00	.....
		4	4	0	130	32.50	269
	8	1	44	28	3	0.20	.....
		2	28	12	16	1.00	
		3	12	4	120	15.00	
		4	4	0	130	32.50	269
	Over 8	1	44	28	3	0.20	.....
		2	228	12	40	2.50	.....
		3	12	4	120	15.00	.....
		4	4	0	130	32.50	293
46.....	1/2	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	10	1.00	.....
		4	4	0	15	3.75	44
	1	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	25	2.50	.....
		4	4	0	30	7.50	74
	1 1/2	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	35	3.50	.....
		4	4	0	85	21.20	139
	2	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	47	4.70	.....
		4	4	0	105	26.25	171
	3	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	65	6.50	.....
		4	4	0	130	32.50	214
	4	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	95	9.50	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		4	4	0	130	32.50	244
	5	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	5	9.50	.....
		4	4	0	130	32.50	269
	6	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	125	12.50	.....
		4	4	0	130	32.50	274
	7	1	46	30	3	0.20	.....
		2	34	14	16	1.00	.....
		3	10	4	140	14.00	.....
		4	4	0	130	32.50	289
	8	1	46	30	3	0.20	.....
		2	30	14	16	1.00	.....
		3	14	4	150	15.00	.....
		4	4	0	130	32.50	299
	Over 8	1	46	30	3	0.20	.....
		2	30	14	25	1.56	.....
		3	14	4	160	16.00	.....
		4	4	0	130	32.50	318
48.....	1/2	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	12	1.00	.....
		4	4	0	20	5.00	51
	1	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	35	2.92	.....
		4	4	0	35	8.75	89
	1 1/2	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	45	3.75	.....
		4	4	0	80	20.00	144
	2	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	60	5.00	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		4	4	0	110	27.50	189
	3	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	90	7.50	.....
		4	4	0	120	30.00	229
	4	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	120	10.00	.....
		4	4	0	130	32.50	269
	5	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	140	11.67	.....
		4	4	0	130	32.50	209
	6	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	160	13.33	.....
		4	4	0	130	32.50	309
	7	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	170	14.17	.....
		4	4	0	130	32.50	.....
	8	1	48	32	3	0.20	.....
		2	32	16	16	1.00	.....
		3	16	4	170	14.17	.....
		4	4	0	130	32.50	.....
50.....	1/2	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	14	1.00	.....
		4	4	0	25	6.25	58
	1	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	40	2.86	.....
		4	4	0	35	8.75	94
	1 1/2	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	55	3.93	.....

DECOMPRESSION TABLE NO. 2 - Continued

[Do not interpolate, use next higher value for conditions not computed]

		4	4	0	90	22.50	164
	2	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	70	5.00	.....
		4	4	0	120	30.00	209
	3	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	100	7.15	.....
		4	4	0	130	32.50	249
	4	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	130	8.58	.....
		4	4	0	130	32.50	279
	5	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	160	11.42	.....
		4	4	0	130	32.50	309
	6	1	50	34	3	0.20	.....
		2	34	18	16	1.00	.....
		3	18	4	180	12.85	.....
		4	4	0	130	32.50	329

§12-134.1-2 Definitions. As used in 29 CFR Subpart S and applied to this chapter:

"29 CFR 1910.20" means section 12-202-3.

"29 CFR 1926.55" means chapter 12-202.

"29 CFR 1926.56" means chapter 12-116.1.

"29 CFR 1926.103" means section 1926.103 in chapter 12-114.2.

"29 CFR 1926.352" means section 12-126-4.

"29 CFR 1926.555" means section 1926.555 in chapter 12-136.1.

"OSHA" means occupational safety and health division, State of Hawaii.

"Secretary of Labor" means the director, department of labor and industrial relations, or the director's designee.

"Subpart D" means chapter 12-112, 12-116.1, 12-117.1, 12-118, 12-201, and 12-202.

"Subpart F" means chapter 12-113.1.

"Subpart J" means chapter 12-126.

"Subpart K" means chapter 12-141.1.

"Subpart M" means chapter 12-121.2.

"Subpart N" means chapter 12-136.1.

"Subpart P" means chapter 12-132.2.

"Subpart U" means chapter 12-125.

"Subpart V" means chapter 12-142.2. [Eff 9/21/96; am 2/8/97; am 7/6/98] (Auth: HRS §396-4) (Imp: HRS §396-4)